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14 . ABSTRACT

The goal of this research is to determine how patient safety and the avoidance of medical error can be effectively taught to student nurses in a simulated setting. A crossover experiment will expose subjects to a) standardized patients, b) high-fidelity, and c) virtual simulations, to teach specific patient safety strategies. Each single exposure will result in less than a 75% mastery of the critical elements of the exercise.

TABLE OF CONTENTS

INTRODUCTION.....	5
BODY.....	1
KEY RESEARCH ACCOMPLISHMENTS.....	1
REPORTABLE OUTCOMES.....	5
CONCLUSION.....	8
REFERENCES.....	8

INTRODUCTION

In current healthcare settings, the opportunity to learn is restricted by: a) the availability of clinical learning opportunity b) the competition among different levels of education (doctors, nurses, paramedics) to learn *in situ* and c) the financial and emotional cost (both to patient and health care providers) of medical error on the part of novice learners. Patient safety concerns have shaped the way in which students can interact with patients at the bedside, and the way in which educators now view the "clinical learning lab". Ziv et al³ take the position that the use of simulation, wherever feasible, conveys a critical educational and ethical message to all: patients are to be protected whenever possible and they are not commodities to be used as conveniences of training.

BODY

STUDY DESIGN

The design is a quasi-experimental, crossover study. Crossover studies have wide use in both healthcare and educational settings and are assistive in defining which, if any, treatments have greater utility over the others. In crossover studies, each subject serves as his/her own control.

The experiment focuses on two aspects of simulation: assessment and training. Assessment defines to what extent simulation alone provides a learning experience that can be measured on a cognitive exam conducted following the simulation and assesses the psychomotor, cognitive and affective levels of ability of students. Training simulation refers to what extent the three modalities (virtual, standardized patients and simulated learning experience) affect scores on both a post-test simulation and a post-test cognitive exam.

Students enrolled in the baccalaureate Nursing program at the University of San Francisco were recruited. Case-scenarios were used in all three exposures (standardized patient, virtual and high-fidelity/simulated learning experience) and were written by experts and validated using content validity by three independent faculty experts. The standardized patient (SP) exposure consisted of theater student majors at USF "acting" out the scenarios. The "virtual" (VP) exposure consisted of a series of video scenarios played out by faculty that present the subject with computer-based recognition and response choices. The "high-fidelity" or "simulated learning experience" (SLE) consisted of scenarios presented in a manikin-based format. Students were randomized to all three experiments in differing order.

Error was embedded in the case scenario but the study objective (recognition of error) will be unknown to the student. The scenarios will be designed so that the student expects to address a different outcome or problem; time to recognition and response will be a factor when considering "mastery". Mastery is defined as meeting an acceptable passing score (75%) that is consistent with the criterion used to assess students in this nursing program.

Using statistical analysis, the incremental effect of each treatment will be determined by comparing students' scores on cognitive exams before and after the treatment. Since the ordering of the treatments may also have an effect on learning and retention, a broader analysis will be conducted to evaluate the impact of not only the treatment, but also the timing of the treatment. There are two factors that should be considered here: First, a treatment may have a different effect if it is administered first, second or third. Second, there may be interactions among treatments, where, for example, administering Treatment A then Treatment B is significantly more effective than administering Treatment C and then Treatment B. These interactions will also be analyzed.

KEY RESEARCH ACCOMPLISHMENTS

RESEARCH TO DATE: FIRST YEAR (2011-2012)

In order to complete the research, three (3) existing classrooms were renovated to create a research laboratory for the simulation study design. To wit: two (2) high-fidelity rooms, equipped to mimic hospital rooms, two standardized patient rooms equipped to mimic physician offices and one (1) computed lab were renovated. All of the rooms were soundproofed to avoid potential contamination among subjects and corridors were created to avoid subjects meeting in hallways. Because this is a crossover study in which all subjects will undergo each of the three experiments, particular attention was paid to the potential for subjects sharing information.

Renovation of the lab was not complete until May, 2012. The first subject were enrolled in June, 2012. This first study served as a pilot test to determine:

- time needed for pre/post testing
- time needed for each experiment
- flow of subjects through lab

Respondents

Over the Summer 2012 term, 20 students were approached about participating in the simulation study. While there is no statistically significant difference in the mean GPAs between those agreeing and those not, the variability in the GPAs is greater. Both the largest (3.99) and the smallest (2.78) GPAs were among the non-participants. Table 1 summarizes the GPA statistics.

Table 1: GPA statistics for study participants and non-participants

	Number	Average GPA	Standard Deviation of GPA
Participants	15	3.488	0.2737
Non-Participants	5	3.494	0.4565

Of the 15 participants, 3 never came to do the study. Their average GPA is lower than that of those who came for at least one treatment (3.22 vs. 3.55).

TESTING THE RESEARCH OBJECTIVES

The following objectives were tested in the pilot study Summer 2012:

Research Objective #1: To determine if one of three methods or a combination of simulation instruction provides greater mastery in patient safety instruction for pre-licensure students.

Research Objective #2: To determine if the sequence of three methods of simulation instruction predicts mastery of patient safety instruction for pre-licensure students.

Research Objective #3: To determine if prior exposure during training simulations can predict how students will perform relative to non-participants on a final simulation.

STATISTICAL ANALYSIS

Exam Question Evaluation

The 10-question pre- and post-test exam is evaluated for the effectiveness of the questions. Table 2 shows the difficulty level of the questions. Difficulty level is measured as a percentage of students answering the question correctly; observations from all pre- (post-) exams are aggregated.

Table 2: Percentage of students answering questions correctly before and after treatment

Question	Pre-test Percentage	Post-test Percentage
1	85.71%	90.48%
2	76.19%	76.19%
3	23.81%	23.81%
4	95.24%	100.00%
5	76.19%	85.71%
6	57.14%	57.14%
7	30.43%	34.78%
8	90.48%	85.71%
9	42.86%	42.86%
10	47.62%	52.38%

Based on the difficulty level, question 4 should be eliminated because too many students answer correctly. Question 8 may also be considered for elimination. Question 3 may be too challenging for students; in the second and third experiments, 0% and 17% of students answered the question correctly, respectively.

Simulation Performance

Participants are scored on a 13-item checklist for desired actions during patient interactions. Scores are expressed as the percentage of items performed. Students are randomly assigned to one of four groups. Each group is exposed to simulation treatments in a different order, see Table 3:

Table 3: Order of simulation exposure per group

Group	1 st Treatment	2 nd Treatment	3 rd Treatment
A (control group)	High fidelity		
B	Standardized patient	Virtual reality	High fidelity
C	Virtual reality	High fidelity	Standardized patient
D	High fidelity	Standardized patient	Virtual reality

Table 4 shows participant scores for each of the treatments, as well as the sample size. Because of the extremely small sample sizes, no general conclusions can be drawn about changes in performance.

Table 4: Average participant score (sample size)

Group	1 st Treatment	2 nd Treatment	3 rd Treatment
A (control group)	61.54% (2)		
B	61.54% (2)	-	53.85% (1)
C	65% (4)	46.15% (2)	53.85% (3)
D	41.03% (3)	38.46% (2)	80% (2)

Table 5 shows the average score across groups for each of the types of simulation. There appears to be no significant difference between performance on a standardized patient and a high fidelity environment.

Table 5: Average scores for each treatment type

Treatment	Average Score
Standardized patient	51.65%
Virtual reality	70%
High fidelity	49.04%

Because of the extremely small sample size, no real conclusions can be drawn from the pre- and post-tests conducted on participants. Table 6 shows the percent change in exam score (post-test % correct – pre-test % correct), the number of observations with no change in exam score, and the number of observations. Treatment 3 has the largest change, with 2 participants each increasing their score by 40%.

Participant Survey

After all 3 treatments, participants were asked to complete a 25-question survey about their experience. Each question was answered by 4 or 5 participants. 20 of the questions asked specifically about the students' perception of the simulations and the learning effect, e.g., "I feel more confident recognizing changes in the patient's condition." The other 5 questions (#11, 13, 14, 23, 25) may be interpreted more generally, e.g., "I am having difficulty prioritizing patient care needs." Table 7 summarizes the number of students feeling negatively, neutrally, positively, and very positively in both categories.

Table 7: Tabulation of participation perceptions

	Very positive	Positive	Neutral	Negative
Simulation-specific question	6	9	4	1
General question	5			

The only question that received a negative response was the first question, "I feel better prepared to care for real patients." The vast majority of all other questions were answered positively.

RESEARCH OBJECTIVE NOT YET TESTED

Research Objective #4: To design a rubric/model for safety instruction capable of stratifying average and exceptional performance.

The academic year 2012-2013 will be used to enroll two (2) additional cohorts of subjects. Development of the rubric will begin Summer, 2013.

CONCLUSION

Enrollment and retention of subjects is a significant issue in this longitudinal study that requires three (3) visits to the laboratory over one (1) semester. Strategies will need to be identified to overcome this issue.

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